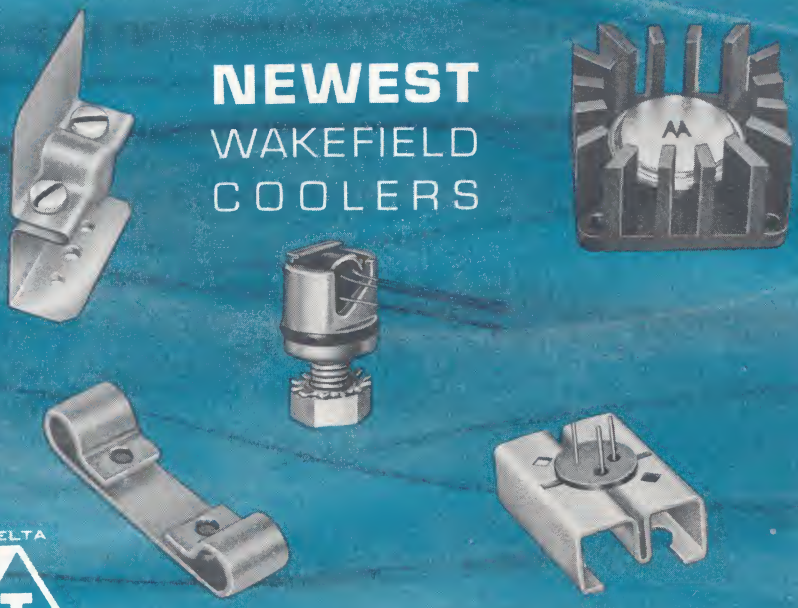
WAKEFIELD HEAT SINKS

For Milliwatt to High Power Semiconductors



NEWEST
WAKEFIELD
COOLERS

DELTA
DIVISION

DISTRIBUTOR PRODUCTS CATALOG NO. 1966

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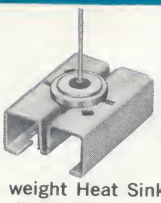
DELTA DIVISION

SERIES 140

NEW . . . WAKEFIELD . . . CIRCUIT BOARD HEAT SINKS



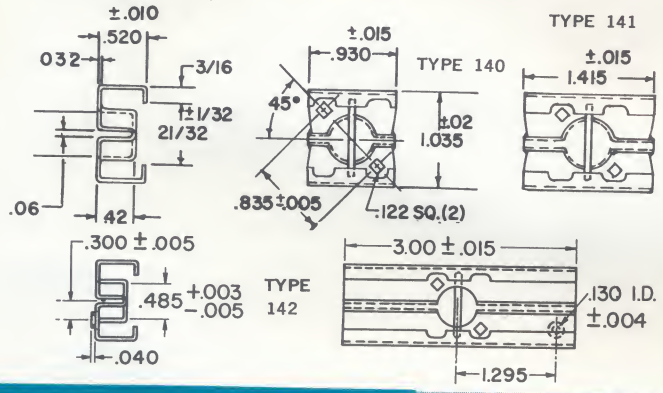
WAKEFIELD ENGINEERING has embarked upon the development of a line of inexpensive, yet functional and thermally well-designed circuit board coolers. Series 140 supplements the Series 200 Feather-weight Heat Sinks. Types 140, 141 and 142 house popular press fit diodes and SCRs as well as the JEDEC TO-8 case style. The cross slot design permits semiconductor cavity to expand cylindrically, thus hugging case diameters ranging from .480 to .505.

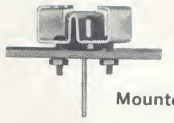
Series 140 Heat Sinks provide thermal resistance as low as 10°C/w. Type 140-C Spring Retention Clip may be used in applications where cooling is critical and the very best thermal contact between case and sink is needed.

MATERIAL: High thermal conductivity commercially pure 1100 alloy aluminum.

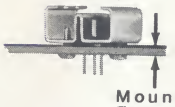
FINISH: Black anodize is standard. For gold irridite finish, add -GI suffix to part number, or for no finish, -NF. GI or NF parts available from factory stock.

FASTENERS: WAKEFIELD Type 100 Nylon fasteners, #4 screws or the Type 140-C stainless steel spring retention clip can be used for mounting. A staking press is required to turn down tabs on Type 140-C Retention Clip.



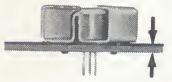


Mounted with screws.



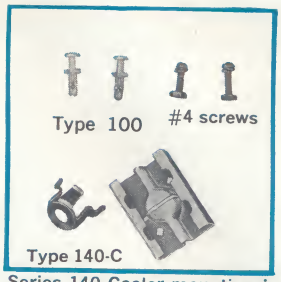
3/32" max.

Mounted with Type 100 Fasteners for TO-8 only.



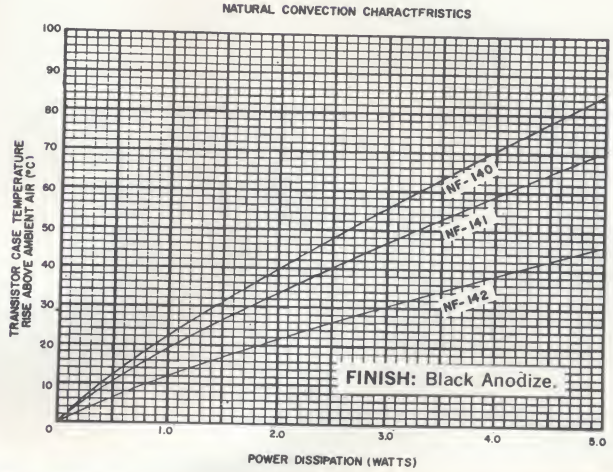
.093 ±.015

Mounted with Type 140-C Clip for TO-8 only.



Series 140 Cooler mounting is accomplished with #4 screws, Type 100 Nylon Fasteners or the Type 140-C Spring Clip which must be ordered separately.

NOTE: See page 13 for Type 100 Fasteners.



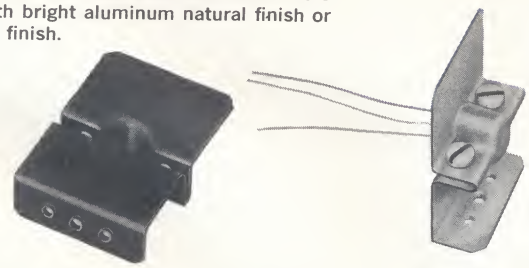
DELTA DIVISION

TYPE 150

NEW . . . WAKEFIELD . . . CIRCUIT BOARD COOLER FOR TO-5 TRANSISTORS

Where space on the circuit board is at a premium, the new Type 150 Heat Sink requires only 0.375 in.² area. In applications permitting 1⅜" height above the circuit board, this lightweight, economical Cooler has good performance characteristics with TO-5 cases: case rise 40°C @ 1 w with bright aluminum natural finish or 34°C @ 1 w with black anodize finish.

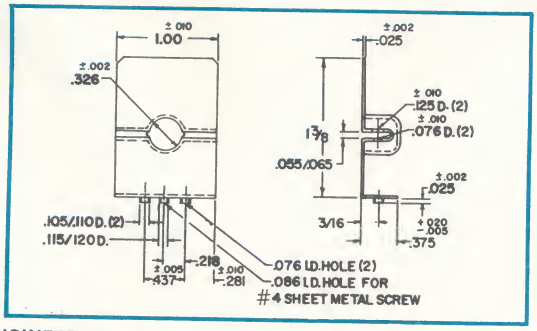
Two #4 x ¼" long sheet metal screws are used to solidly clamp the TO-5 case in the Type 150 Heat Sink. Three eyelets extruded from the mounting base provide keying to the circuit board. A sheet metal screw in the center eyelet anchors the Heat Sink to the board. Three ⅛" holes on 3/32" centers should be drilled in the board for mounting.

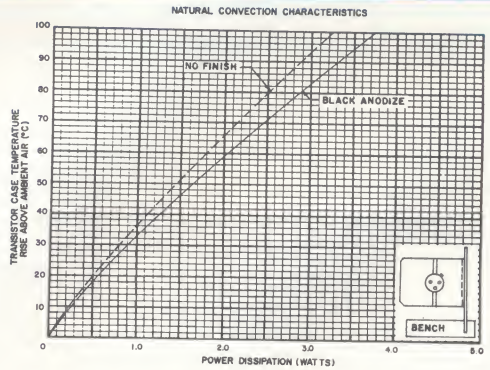


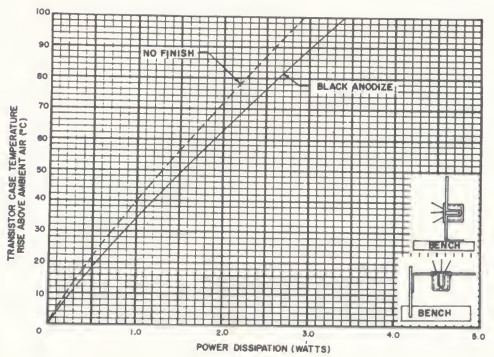
MATERIAL: 1100 aluminum alloy.

FINISH: Black anodize is standard. For gold irridite finish, add -GI suffix to part number, or for no finish, -NF. GI or NF parts available from factory stock.

(Screws are not furnished.)



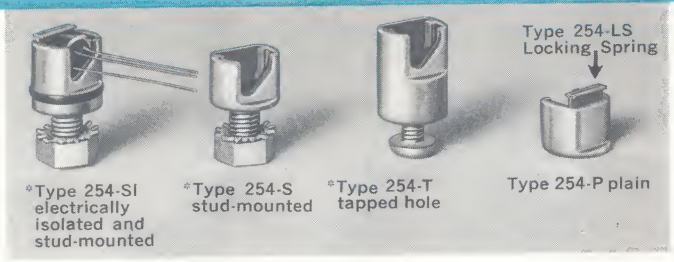




Copyright 1965 by WAKEFIELD ENGINEERING, INC.

NEW . . . WAKEFIELD . . . THERMAL RETAINERS FOR TO-5 CASES

DELTA DIVISION **SERIES 254**



At power dissipations above 1½ or 2 watts, TO-5 case style transistors, having the silicon die attached to the header, are best heat sinked at the bottom face of the header. Series TR-254 Thermal Retainers provide this preferred contacting method. All four types are intended as thermal links from the transistor case to a cooler or to a chassis member acting as the heat sink.

†Type 254-SI has built-in 500 volts a-c electrical isolation with DELTA BOND 152 Thermally Conductive Adhesive used to bond the Type 254-P to a stud. Type 254-LS Locking Spring is inserted behind the transistor. Type 120 Thermal Joint Compound should be applied to transistor header before insertion and between mounting base of the Series 254 unit and chassis. However, Type 254-P may be soft soldered or bonded to chassis with Type 152 Adhesive.

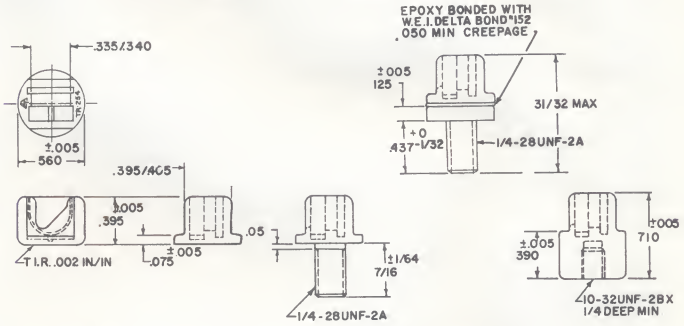
MATERIAL: Zamak 3. Stud material in Type 254-SI is 6061-T6 aluminum with gold irridite finish. Type 254-LS Locking Spring material is stainless steel.

FINISH: Chromate conversion. Type 254-P also available nickel plated for solder assembly.

*Mounting hardware is not furnished.

THERMAL RESISTANCE: TO-5 case to chassis on which unit is mounted. (Type 120 Thermal Joint Compound is used. See page 16.)

Type 254	P	S	† SI	T
θ case to chassis °C/w	4	4.1	6.0	5.3

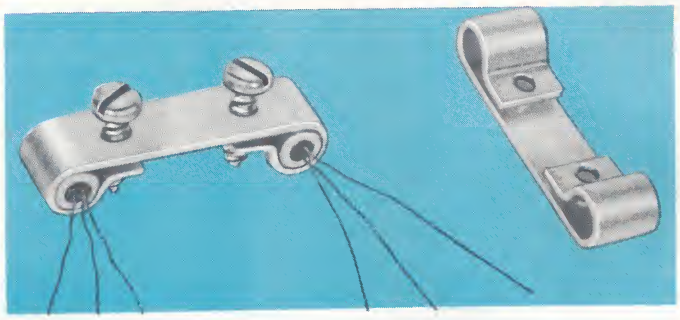


†Type 254-SI units rated 1000v a-c available on special order.

NOTE: See page 15 for Delta Bond 152 Adhesive and page 16 for Type 120 Thermal Joint Compound.

NEW . . . THERMAL CLAMP FOR TO-1 CASES

TYPE 255

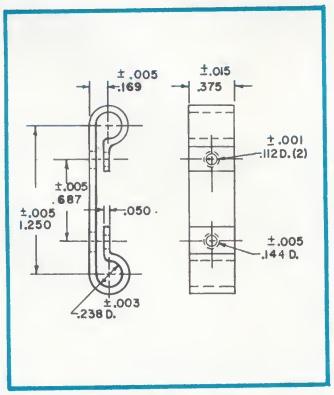


For push/pull driver or low power output applications using TO-1 case style transistors, this versatile thermal clamp provides solid, economical retention of the cases to a chassis or heat sink. Two cases can be mounted in the Type 255 Thermal Clamp. 3°C/w per TO-1 transistor is obtained or 1½ °C/w for both. Mounting centers are kept broad to better distribute the power from the two transistors across the chassis or heat sink. This also permits sufficient circuit board space for mounting components common to the transistors.

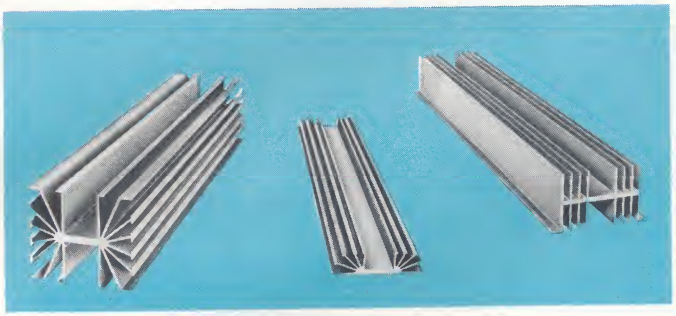
#6 sheet metal or self-tapping screws can be used from the chassis thru the Type 255 Clamp. Or, #3 machine screws with nuts can be used from either direction. (Screws are not furnished.)

MATERIAL: 1100 aluminum alloy.

FINISH: No finish is standard. Add -BA suffix to part number for black anodize or -GI for gold irridite. GI and BA parts available from factory stock.



HEAT SINK EXTRUSIONS



EXTRUSIONS IN 3-FT. LENGTHS (± ¼")

Type No.	For Cooler Type	Width	Height	Refer Pg. No.
300	NC-301-303	2.00	2.00	5
400	NC-401-403	4.81	1.25	6
410	NC-413	4.81	1.87	6
420	NC-421-423	4.81	2.63	6
440	NC-441	4.75	4.50	6
600	NC-601-603	2.24	.56	8
620	NC-621-623	4.81	.46	8
640	NC-641	4.12	1.00	8
1157	GN-1157-5	4.12	4.12	10
1251	GN-1251-5.5	5.00	5.00	10
1244	WN-1244-5	4.00	4.00	11
1245	WN-1245-6	5.00	5.00	11
1541	WN-1541-6 & 9	6.25	6.25	11
2131	MN-2131-3.5, 6 & 9	9.25	6.75	12
2159	MN-2159 (Insert)	3.375	3.437	12

DELTA DIVISION **SERIES 200**

FEATHERWEIGHT SNAP-ON SEMICONDUCTOR HEAT DISSIPATORS are compatible with the entire JEDEC Case Tolerance Range

The unique fin design permits horizontal or vertical orientation with excellent natural convection performance in either position. Similarly in forced convection applications, the axis of the semiconductor may be oriented either perpendicular or parallel to the direction of air flow.

The resilient design combined with precision manufacturing assure excellent thermal contact between cooler and case. The contact circumference is approximately 75% of the case circumference. Using no grease or joint compound, the maximum contact thermal impedance from the semiconductor case to the dissipator ID is 5°C/w for Models 201, 202, 203 and 222, 3°C/w for Models 204, 205, 207, 209 and 224, and 2°C/w for Models 211, 213 and 215. Silicone grease will reduce the above impedances by a factor of 2. DELTA-T No. 120 Thermal Joint Compound (see page 16) will reduce them by a factor of 8.

Series 200 Featherweight Coolers are made from a beryllium copper alloy having twice the thermal conductivity of the more commonly used alloys. This assures maximum performance per unit weight. These Coolers have been included in numerous equipments subjected to MIL environmental shock and vibration tests without any recorded failures to date.

MATERIAL: Beryllium copper per MIL-C-81021.

*__FINISH:__ Black ebonal "C" meeting joint Army-Navy specification MIL-F-495 is standard; other finishes available on request.

SPECIFICATIONS:

Model	Fig. No.	Fits Case Diameters	Fits JEDEC Case Styles	A +.010 −.015	B ±.040	C
201	1	.161/.240	TO-18, 24, 28,	.150	.640	—
202	1		40, 44	.150	.490	—
203	2			.150	.640	—
204	1	.275/.370	TO-5, 9, 11, 12, 16, 26, 29, 33, 39, 42, 43, 45	.255	.550	—
205	1			.255	.720	—
207	2			.255	.720	—
209	3			.255	1.280	.720 ± .040
211	1	.440/.544	TO-8, 38, 48	.420	.830	—
213	2			.420	.830	—
215	3			.420	1.400	.830 ± .040
222	4	.165/.240	2 pcs. TO-18, 24, 28	.150	.640	.380 ± .015
224	4	.275/.370	2 pcs. TO-5, 9, 11, 12, 16, 29, 33, 39, 42, 43, 45	.255	.720	.440 ± .015

NOTE: For Weights, see page 15.

Fig. 1

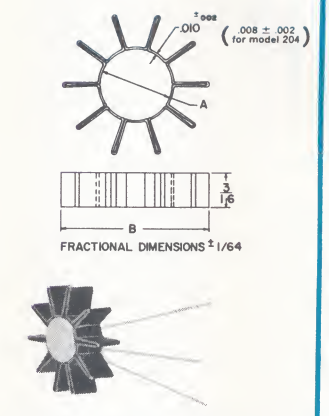


Fig. 2

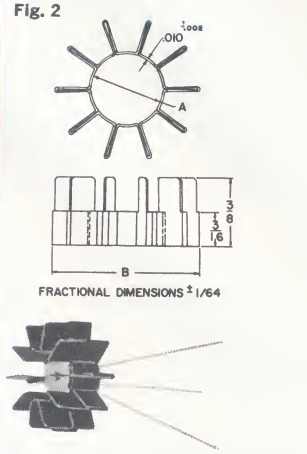


Fig. 3

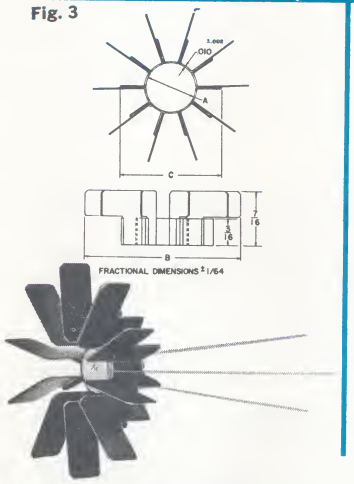
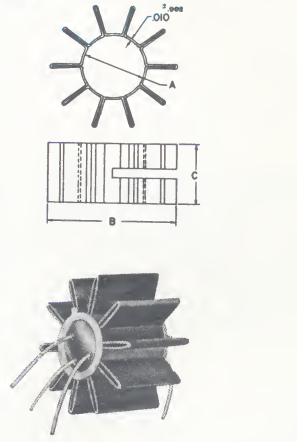
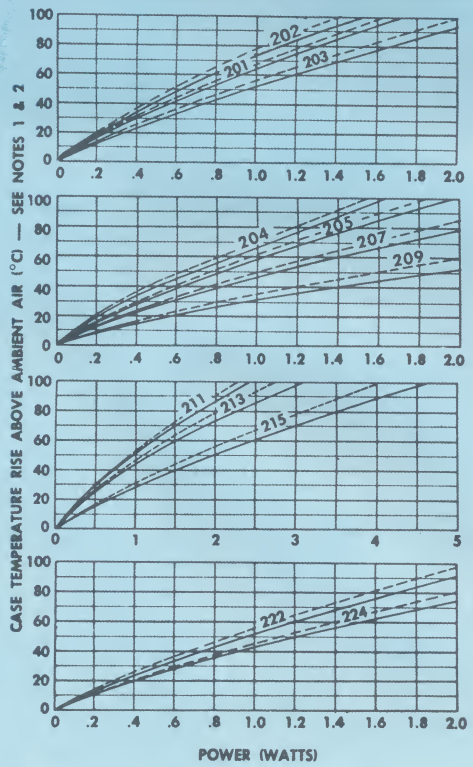


Fig. 4



* Models 201, 203, 205, 207, 209, 211, 213 and 215 are also available in 6061T6 aluminum with gold irridite finish. Natural convection temperature rise is 15% greater than shown on curves. Forced convection data is as shown for beryllium copper units.

NATURAL CONVECTION CHARACTERISTICS



NOTE:

1. Solid lines for semiconductor axis vertical. Dotted lines for semiconductor axis horizontal.
2. Both forced and natural convection data taken with silicone grease between semiconductor case and heat sink.
3. Forced convection data taken at a power level of 2 watts with air flow perpendicular to semiconductor axis.

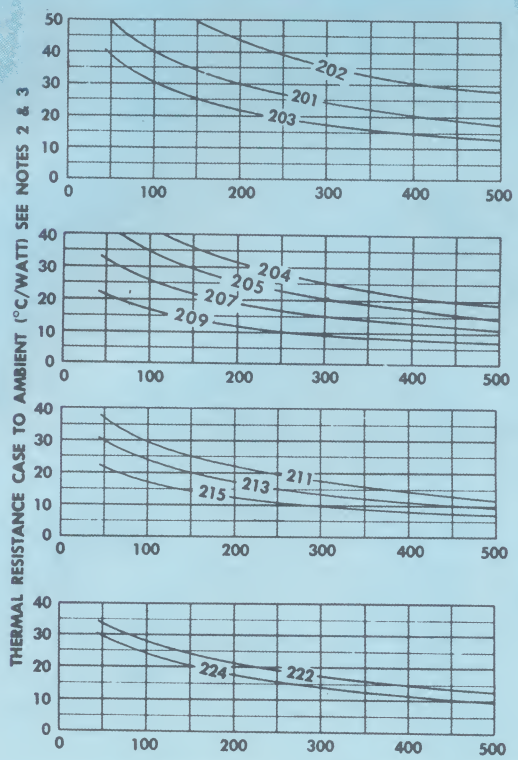
INSTALLATION TOOLS:

MODEL 160

MODEL 161

Although tools are not required for mounting, installation tools do facilitate rapid assembly of all milliwatt coolers. Tool Model 160 accommodates the NF-201, 202, 203, 204, 205, 207, 209, 222 and 224. Tool Model 161 accommodates the NF-211, 213 and 215.

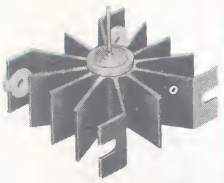
FORCED CONVECTION CHARACTERISTICS



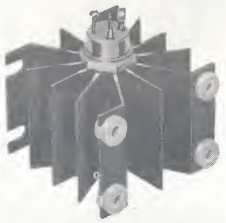
RADIAL FIN SEMICONDUCTOR COOLERS PROVIDE OPTIMUM COOLING AND FLEXIBLE MOUNTING

DELTA DIVISION **SERIES 300**

WAKEFIELD Series 300 Heat Sinks will accommodate stud-mounted (up to 11/16" hex case), press-fitted rectifiers and transistors. Standard models are supplied with MIL SPEC black anodized finish. The semiconductor mounting surface and one mounting foot are free of anodize to assure excellent thermal and electrical performance.



Series 300 Coolers are compact: only 2" square and height is ¾" for Models NC-301, 1½" for NC-302 and 3" for NC-303. Each is ideal for compact stacking arrangements. Electrical isolation is simplified by using Type 103 snap-in Teflon insulators or Type 102A Nylon fasteners with Type 102-F or 102-N Insulating Washers. See page 13.

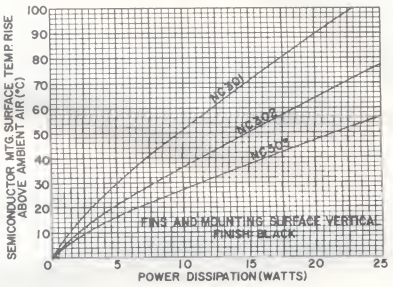


Designed with flexibility of mounting in mind, Series 300 Coolers can be mounted from the bottom or either of the two sides. Two semiconductors can be mounted, one on each end of a single cooler. Improved thermal conductance from transistor to cooler can be obtained by lightly coating the mounting surface with Type No. 120 Thermal Joint Compound.

MATERIAL: Aluminum alloy 6063-T5 per QQ-A-200.
FINISH: Black anodize per MIL-A-8625 Type II.

The radial fin design, combined with large surface area, provides unusually high natural convection cooling per unit volume. NC-303 limits the temperature rise to 47°C at 20w under natural convection conditions. Under forced convection conditions, Model NC-302 provides a thermal resistance under 0.5°C/w with moderate air flow.

NATURAL CONVECTION CHARACTERISTICS

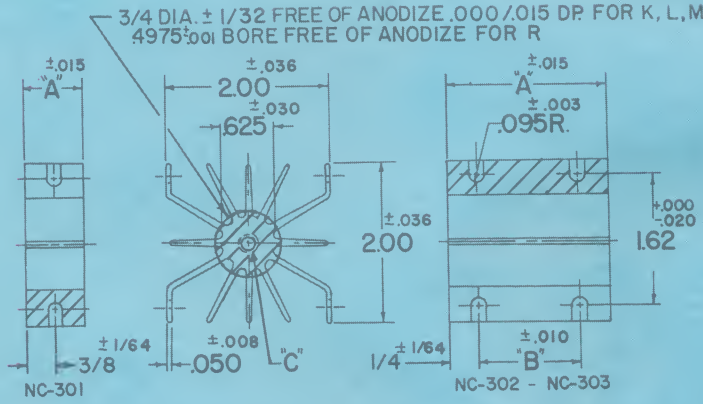


To provide conservative, trustworthy data for design use, the thermal characteristics were taken under rigidly controlled laboratory conditions. NC-300 Cooler characteristics were determined by mounting a thermocouple directly beneath the semiconductor, thereby sensing the hottest portion of the cooler. Natural Convection Curves are shown for units mounted in the vertical position.

Two sets of Forced Convection Characteristics are shown below for NC-300 Coolers. The upper set is for coolers in a large duct which carries an air stream of average velocity as shown on curves. The lower set is for units mounted in a close fitting duct carrying cfm of standard air (.075#/ft³).

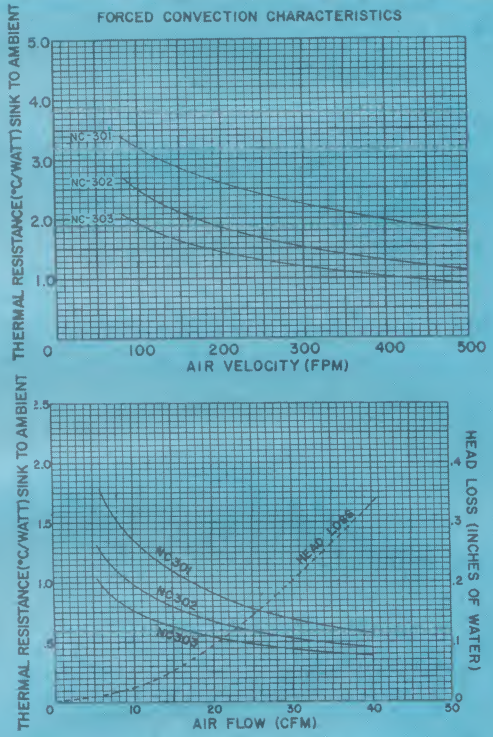
MODEL	DIM. "A"	DIM. "B"	DIM. "C"			
			L	M	N	R
NC-301	3/4	——	8-32 TAP 5/8 +1/4 -0 DP.	10-32 TAP 5/8 +1/4 -0 DP.	1/4-28 TAP 5/8 +1/4 -0 DP.	REAM .4975 ±.001 3/8 +1/8 -0 DP.
NC-302	1 1/2	1.00				
NC-303	3.00	2 1/2				

CROSSHATCHED AREAS FREE OF ANODIZE. "K" IS BLANK NO HOLES.



Because of stud interference NC-301 cannot be used with two L, M or N stud type semiconductors, but may be used with two "R" press fit semiconductors.

FORCED CONVECTION CHARACTERISTICS



RECTIFIER STACKS WITH SERIES 300 COOLERS:

A representative 30 amp rectifier stack, shown at right, uses NC-301 Coolers and new Series 300 Hardware, which obsoletes the rectifier stack designed by WAKEFIELD ENGINEERING in 1961.

Even though Series 300 Heat Sinks and Kit hardware are designed for optimum thermal efficiency, an improvement can be obtained by using WAKEFIELD Type 120 Thermal Joint Compound. Type 120 Compound improves long-term electrical and thermal contact between press fit rectifiers and mounting holes. During assembly, Type 120 Compound prevents galling between the mating parts, and protection against oxidation is also provided. (See page 16.)

NOTE: For Series 300 Rectifier Stack Kit, see page 9. See page 14 for Ordering Instructions and Mounting Accommodations, page 13 for Fasteners and Insulators, page 15 for Weights and page 3 for Extrusions.

DELTA DIVISION **SERIES 400**

NATURAL CONVECTION HEAT SINKS REQUIRE MINIMUM SPACE

Where space is critical, Model NC-401 is unexcelled for natural convection cooling. Excellent forced convection characteristics are also provided with a thermal resistance below 0.5°C/w at moderate air flow.

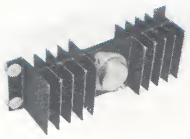
Model NC-403 has a thermal resistance of 1.8°C/w at medium power levels which permits adequate cooling in all but the most stringent applications. With forced convection of moderate air flow, a thermal resistance of only 0.3°C/w may be achieved.

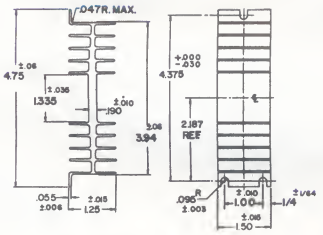
Model NC-413 thermal resistance: as low as 1.4°C/w for natural convection and as low as 0.3°C/w with moderate air flow. For Model NC-421, 1.3°C/w and 0.3°C/w respectively.

MATERIAL: Aluminum alloy 6063-T5 per QQ-A-200.

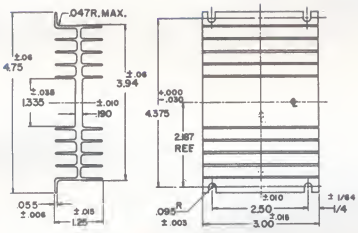
FINISH: Black anodize per MIL-A-8625 Type II.

NC-401

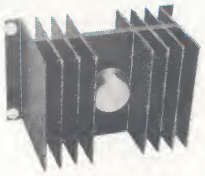


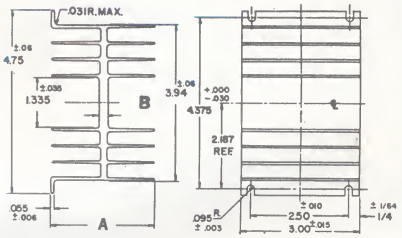


NC-403 WITH MOUNTING ADAPTERS



NC-413 and NC-421

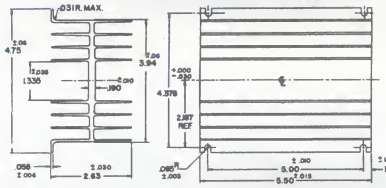




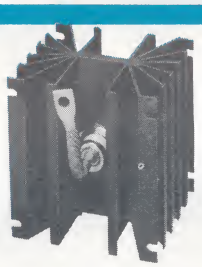
413 (A = 1.88 ± .030) (B = .200 ± .010)

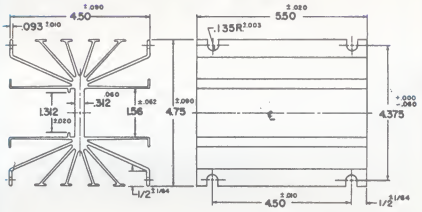
421 (A = 2.63 ± .030) (B = .190 ± .010)

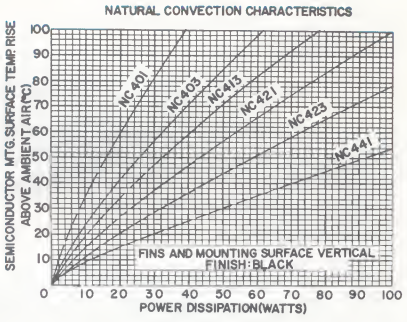
NC-423 WITH MOUNTING ADAPTERS

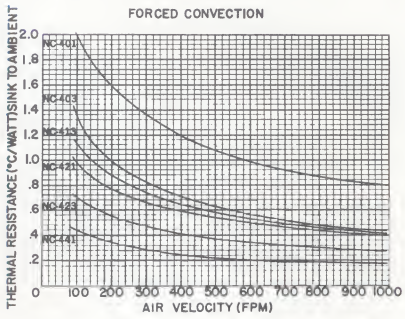


NC-441





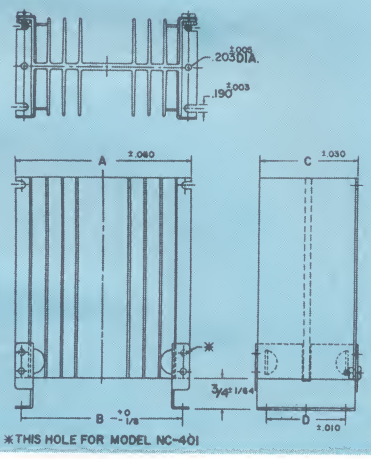


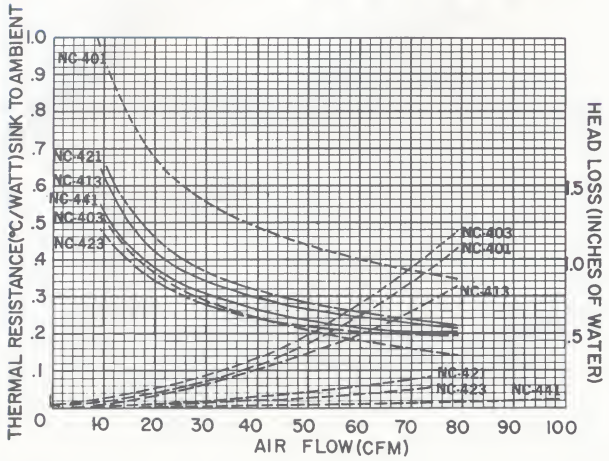


VERTICAL MOUNTING ADAPTERS FOR SERIES 400 AND 420 COOLERS

WAKEFIELD Series 400 Heat Sinks can be supplied with Vertical Mounting Adapters. Series 400 Coolers mounted on these adapters conform to MIL environmental specifications including vibration conditions spelled out by MIL STD 202 condition B. Material: C.R. steel per QQ-S-633. Finish: Cadmium plate and gold irridite per QQ-P-416-A Class 2, Type 2. Brackets may be used with or without Type 103 Teflon insulators. See photos NC-403 and NC-423 above.

Adapter No.	Cooler No.	Dim. A	Dim. B	Dim. C	Dim. D
111	NC-401 NC-403	4¾	4⅜	1¼	1.00
113	NC-421 NC-423	4¾	4⅜	2⅝	2⅛



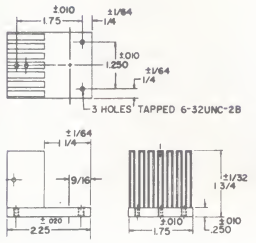


NOTE: For Ordering Instructions and Mounting Accommodations, see page 14. For Fasteners and Insulators, see page 13. For Thermal Joint Compound, see page 16. For Weights, see page 15.

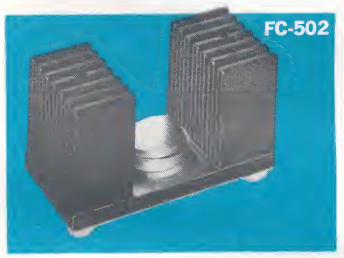
COPPER FORCED CONVECTION COOLERS PERMIT MAXIMUM HEAT TRANSFER IN MINIMUM SPACE

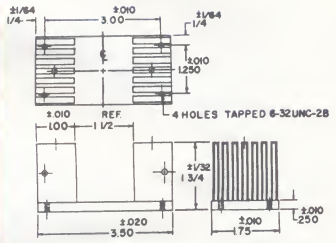
DELTA DIVISION **SERIES 500**

COPPERCOOL Heat Sinks available with Hose Adapters and Covers

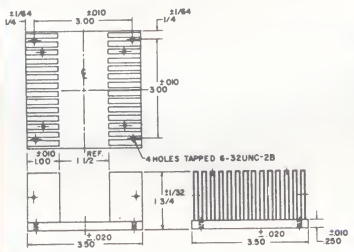


Minimum equipment space is required with the FC-501 Cooler. The use of copper, with optimized fin spacing, achieves the equivalent cooling performance of much larger aluminum units, permitting greater latitude in packaging.

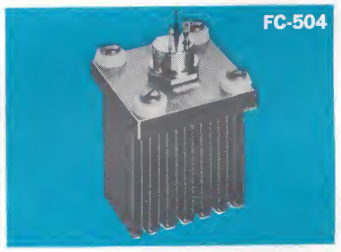


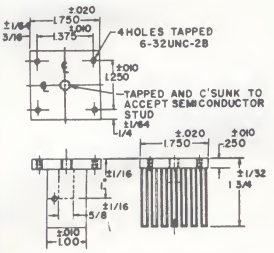


The FC-502 Cooler achieves a lower thermal resistance than most available semiconductor heat dissipators while consuming far less chassis mounting space.

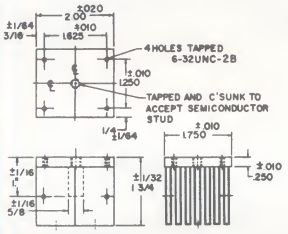


Model FC-503 is suited to high power stud-mounting transistors dissipating as much as 250w. Also adaptable to high current rectifiers and controlled rectifiers or where low temperature rises achieved at high power levels.





Stud-mounted semiconductors are positioned directly in the center of the fin base so a conduction path of 360° is achieved with Model FC-504. This accomplishes maximum cooling in a greatly reduced volume.



Model FC-505 is recommended where FC-504 does not give sufficient low thermal resistance. Twice the fin area achieves 0.25°C/w with little additional space. Also is adaptable to thermoelectric devices.

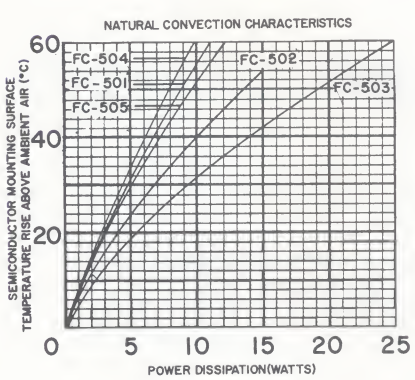
MATERIAL: Base, Copper per QQ-C-504. Fins, Copper per QQ-C-576.

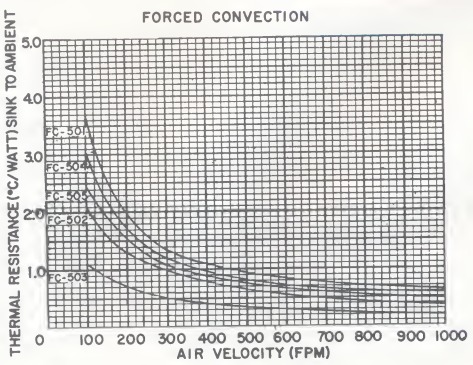
FINISH: Black ebonal "C" per MIL-F-495.

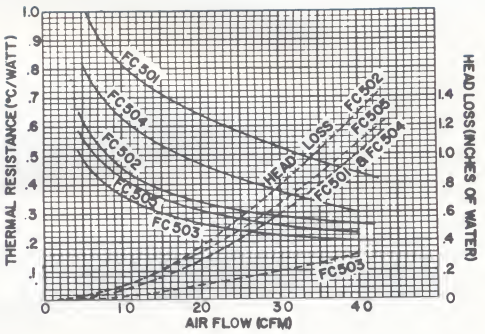
CFM Forced Convection Characteristics were obtained with a top cover in place and with the unit mounted in a close-fitting opening in a plastic baffle plate. Entire air flow was constricted through the fins. FPM Forced Convection Characteristics were obtained with an unshrouded unit mounted in a large duct. A thermocouple was mounted directly beneath the semiconductor to sense the hottest point on the cooler in each test.

HOSE ADAPTERS AND COVERS are accessories and must be ordered separately.

MATERIAL: C.R. steel per QQ-S-633.
FINISH: Black oxide per MIL-F-13924 Class 2 — Grade A.





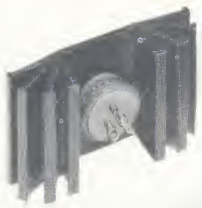


NOTE: For Ordering Instructions and Mounting Accommodations, see page 14. For Fasteners and Insulators, see page 13. For Thermal Joint Compound, see page 16. For Weights, see page 15.

DELTA DIVISION

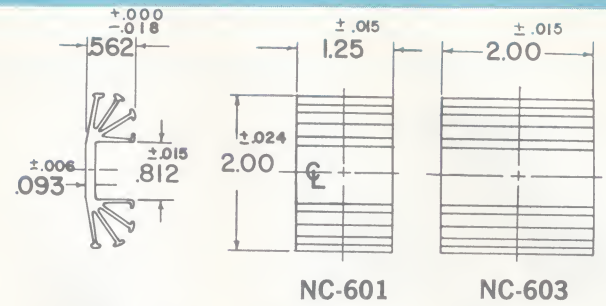
SERIES 600

HEAT SINKS FOR MOUNTING ON CIRCUIT BOARDS AND ON CHASSIS EXTERIORS



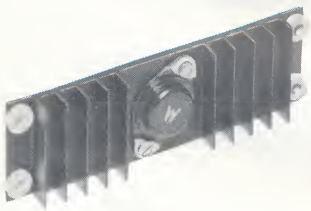
NC-601 — Ideal for printed circuit boards. Dissipation up to 10W using silicon TO-8 case transistor in a 40° ambient under natural convection conditions.

NC-603 — Specially designed to accommodate TO-8 package with heat sink clamp. Provides ample cooling at 10 watts for TO-8 silicon transistor under natural convection conditions at 60° C ambient.



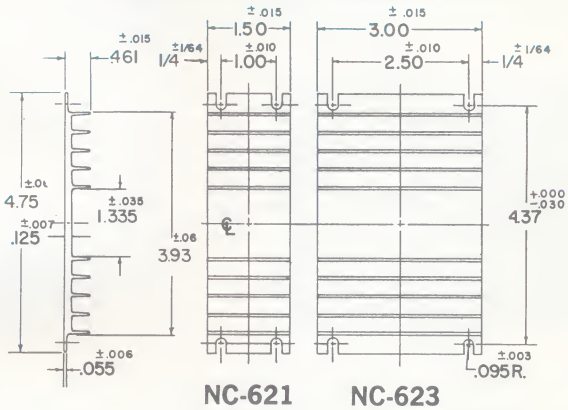
NC-601 NC-603

(ACCEPTS ONLY MOUNTINGS E, F, K, R, T and U)

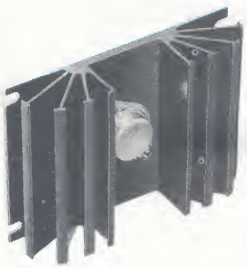


NC-621 — Low profile cooler ideal for compact designs. Minimum mass for shock and vibration conditions. 4.5° C/W with natural convection cooling.

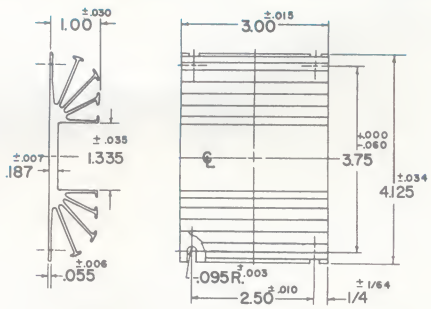
NC-623 — Excellent for replacing marginal flat plates dissipation. Accepts all transistor case styles. Provides 3.5° C/W under natural convection conditions.



NC-621 NC-623



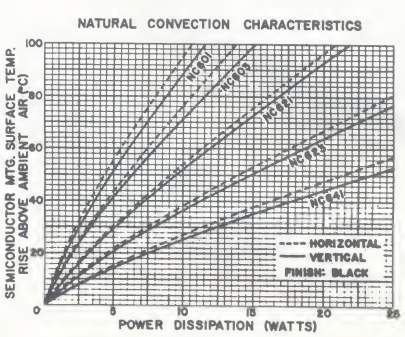
NC-641 — Optimized fin design provides unusually large surface area for maximized natural convection. Attractive profile for external mounting.

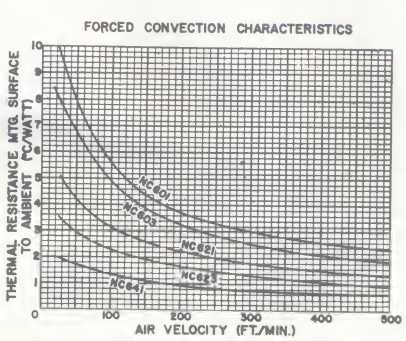


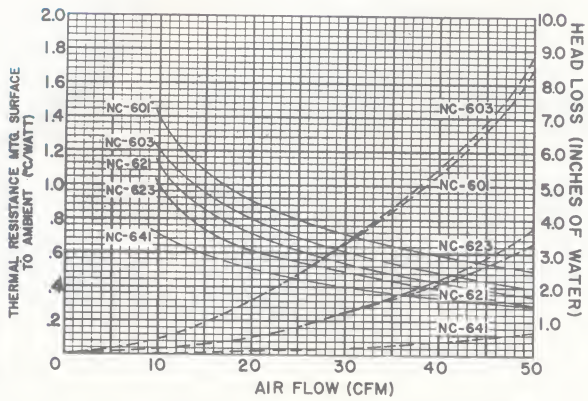
NC-641

The thermal characteristics of Series 600 Coolers were determined by mounting an open junction thermocouple directly beneath the semiconductor, thereby sensing the hottest portion of the cooler. The forced convection characteristics are for a cooler mounted flush against a plastic board so air flow was blocked on the back surface. When a cooler is mounted ¼" or more off the circuit board, 10% to 15% lower thermal resistance is achieved.

MATERIAL: Aluminum alloy 6063-T5 per QQ-A-200.
FINISH: Black anodize per MIL-A-8625 Type II.





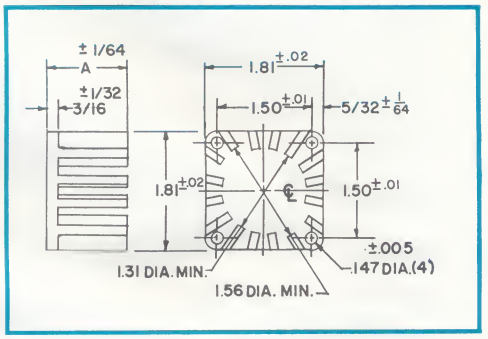


NOTE: For Ordering Instructions and Mounting Accommodations, see page 14. For Fasteners and Insulators, see page 13. For Thermal Joint Compound, see page 16. For Weights, see page 15. For Extrusions, page 3.

NEW . . . WAKEFIELD . . . CIRCUIT BOARD HEAT SINKS FOR OPTIMUM COOLING

DELTA DIVISION **SERIES 680**

NC-680-.5 NC-680-.75 NC-680-1.0 NC-680-1.25



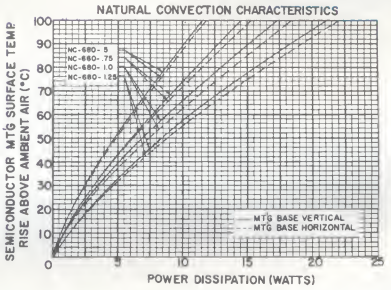
New Series 680 Heat Sinks will provide optimum natural convection cooling per unit volume occupied above the circuit board. Units permit free circulation of air from any direction so mounting in any position is possible. This Heat Sink accepts all popular transistors such as T03, T036, 2N1016, et cetera. Series 680 Heat Sinks are impacted from a high thermal conductivity aluminum alloy. All models in Series 680 have the same base size of 1.81" x 1.81" with 1.50" between centers of the four corner holes.

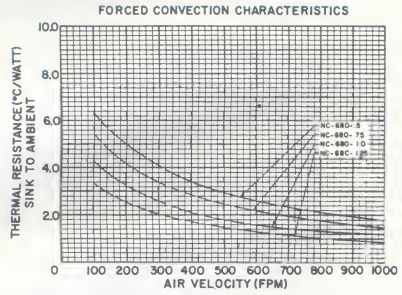
Model No.	Dim. "A"
NC-680-.5	.50"
NC-680-.75	.75"
NC-680-1.0	1.00"
NC-680-1.25	1.25"

MATERIAL: 1100 aluminum per Mil-A-12545.

FINISH: Black anodize per Mil-A-8625 Type II.

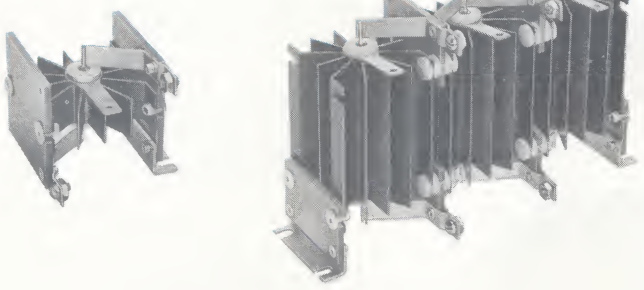
Natural convection characteristics are shown for all models mounted with base plane vertical and also horizontal. Natural and forced convection characteristics were measured with units flush against a plastic board so that air flow was blocked on the back surface. For instance with Model NC-680-1.25, natural convection performance is 5°C/w sink rise above ambient at 15w power level and forced convection performance is 1.5°C/w at an air velocity of 500 fpm. To achieve even lower thermal resistance, the heat sink can be mounted ¼" or more off the circuit board. WAKEFIELD Type 120 Thermal Joint Compound provides improved thermal conductance from transistor to heat sink.





NOTE: For Ordering Instructions and Mounting Accommodations, see page 14. See page 15 for Weights and page 16 for Thermal Joint Compound.

SERIES 300 HARDWARE FOR PRESS FIT RECTIFIER STACKS



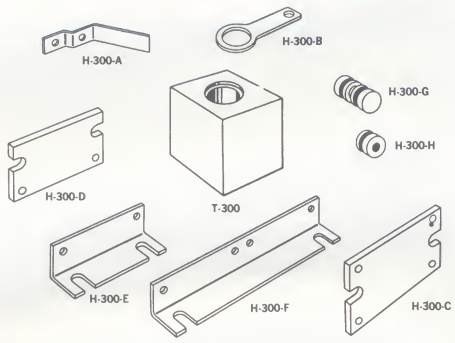
The time available to build a prototype power supply after a requirement has been defined is frequently short. Standard hardware, available now in Series 300 Designer/Builder Kit or in bulk form, will permit the user to build his own press-fit rectifier stack from Series 300 Heat Sinks when the stack is needed. Costs can be kept low by using these standard production parts and by supplying your own assembly labor. WAKEFIELD has not yet found a limit to the number of possible configurations that can be built with this hardware. The designer's ingenuity can be used to assemble clever arrangements and to minimize the number of parts required per configuration.

All Series 300 hardware is pre-finished and ready for assembly. High strength, high temperature resistant glass-filled teflon is supplied as the standard insulating material in spools and grommets. All materials and finishes meet MIL specs. Most underwriters' equipment specifications are met insofar as insulation is concerned.

Fasteners, such as screws or rivets, are not supplied since most companies have them in stock. For assembling prototypes, screws should be used to permit easy revision. But the economy of rivets, eyelets or the popular "POP" rivets may be realized when production quantities are to be built.

NOTE: For Series 300 Heat Sinks, see page 5.

SERIES 300 DESIGNER/BUILDER KIT CONTENTS



Part No.	Name	Material	Finish	Quan.
H-300-A	Offset bus bar	Copper	Cadmium plate & gold irridite	24
H-300-B	Rectifier lug	Copper	Cadmium plate & gold irridite	10
H-300-C	301 insulating support	Phenolic XXXP	——	4
H-300-D	302/303 insulating support	Phenolic XXXP	——	20
H-300-E	Single mounting foot	Steel	Cadmium plate & gold irridite	6
H-300-F	Double mounting foot	Steel	Cadmium plate & gold irridite	4
H-300-G	Insulating spool	Glass Filled Teflon	——	24
H-300-H	Grommet insulator	Glass Filled Teflon	——	8
T-300	Rectifier driving blocks	Aluminum	——	2

DELTA DIVISION

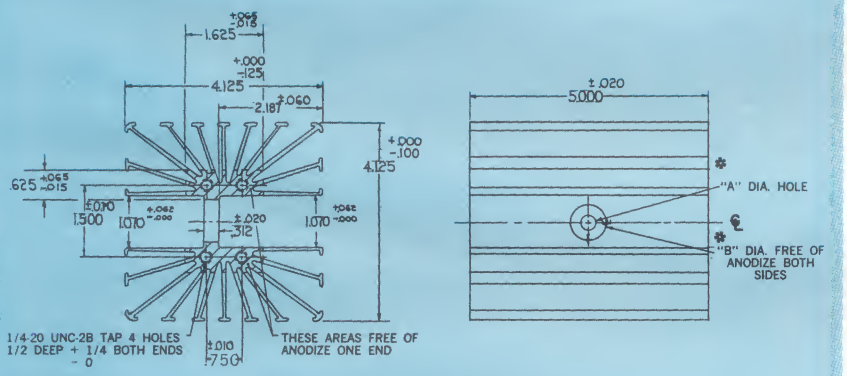
SERIES GN

SERIES GN KING SIZE HEAT SINKS . . . end-mounted for 1-1/16" and 1-1/4" hex size High Power Rectifiers and SCRs . . .

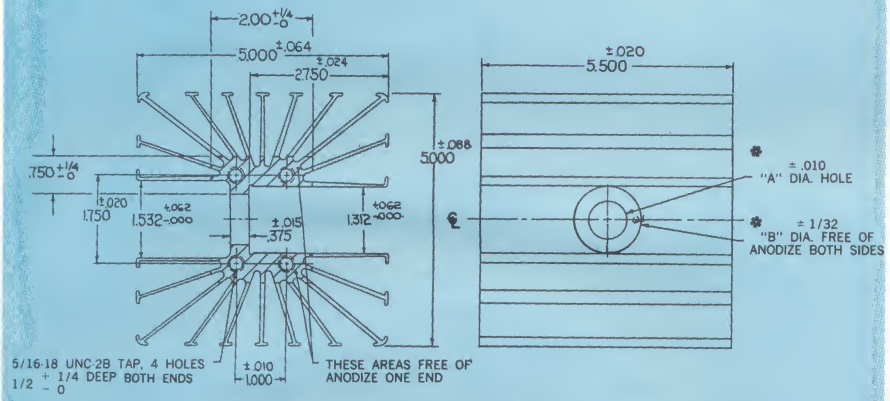
DELTA-T King Size Natural Convection Heat Sinks are designed for systems requiring high reliability such as telephone power supplies, mine equipment rectifiers, etc. These units replace forced convection flat plate assemblies, eliminating fans and the reliability problem attendant to fans. Fin efficiency is increased by the radial fin design which decreases conduction path length between semiconductors and fin area. The aluminum King Size Heat Sink is black anodized. Each semiconductor mounting surface is free of anodize for the electrical stud connection. Also, two bare aluminum surfaces and four tapped holes are provided for bolting this end-mounted Heat Sink directly to a bus bar. Tapped holes in the other end may be used for bolting auxiliary terminals, plastic support bars, etc.

MATERIAL: Aluminum alloy 6063T5 per QQ-A-200.

FINISH: Black anodize per MIL-A-8625 Type II.



MODEL GN-1157-5

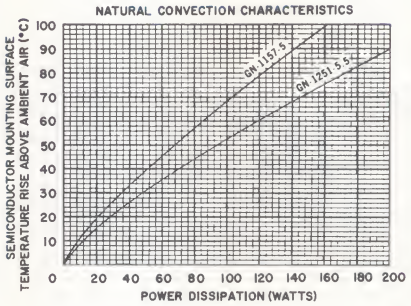


MODEL GN-1251-5.5

***NOTE:** For Ordering Instructions and Mounting Accommodations, see page 14. For Thermal Joint Compound, see page 16. For Weights, see page 15. For Extrusions, page 3.

NATURAL CONVECTION CHARACTERISTICS

. . . taken under rigidly controlled lab conditions.

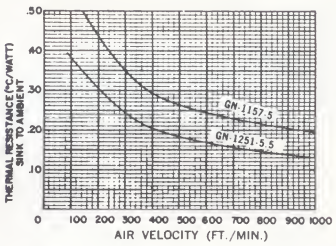


FORCED CONVECTION CHARACTERISTICS

If high ambient temperature or unusually high power dissipation mandates thermal impedance lower than natural convection thermal impedance, then forced air with quite low flow velocity from low speed fans may be used with Series GN or WN Heat Sinks.

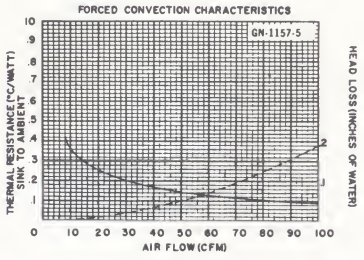
The following charts of forced convection characteristics are for Series GN Heat Sinks. Chart No. 1 is for sinks in a large duct carrying a stream of .075 lbs/ft³ air with velocity as shown on curves.

1.

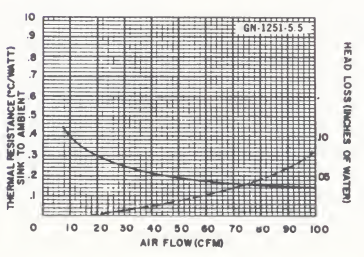


Charts No. 2 - 3 are for sinks in closely confined cuts. The cfm of .075 lbs/ft³ density air flowing through each sink is shown on the curves along with the static head loss across the sink.

2.



3



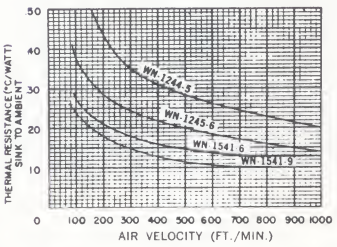
SERIES WN KING SIZE HEAT SINKS . . .
foot-mounted for 1-1/16", 1-1/4" and 1-3/4" hex size High Power Rectifiers and SCRs . . .

DELTA DIVISION **SERIES WN**

FORCED CONVECTION CHARACTERISTICS

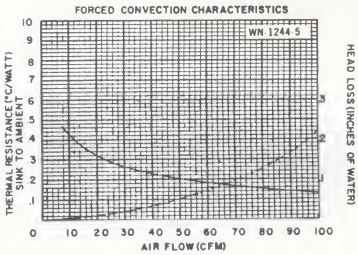
The following charts of forced convection characteristics are for Series WN Heat Sinks. Chart No. 1 is for sinks in a large duct carrying a stream of .075 lbs/ft³ air with velocity as shown on curves.

1.



Charts No. 2 - 5 are for sinks in closely confined ducts. The cfm of .075 lbs/ft³ density air flowing through each sink is shown on the curves along with the static head loss across the sink.

2.



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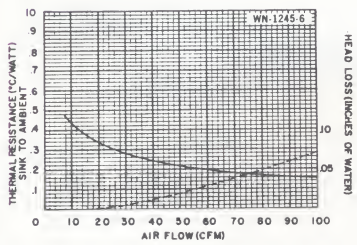
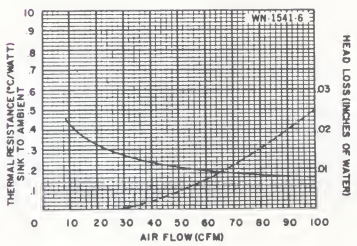
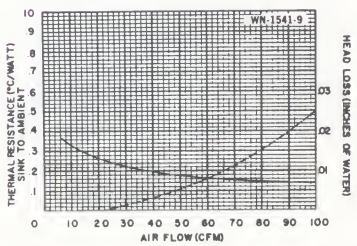


4.

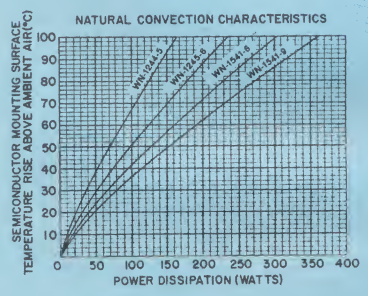


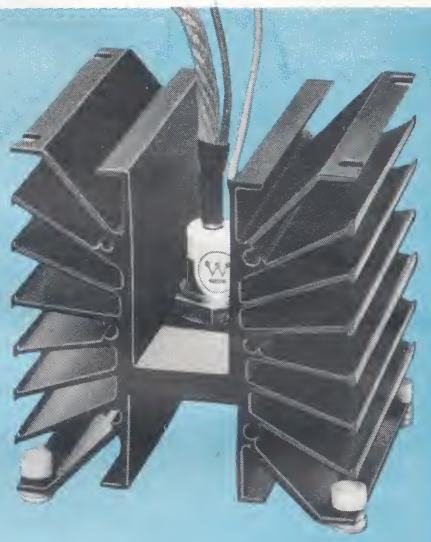
5.

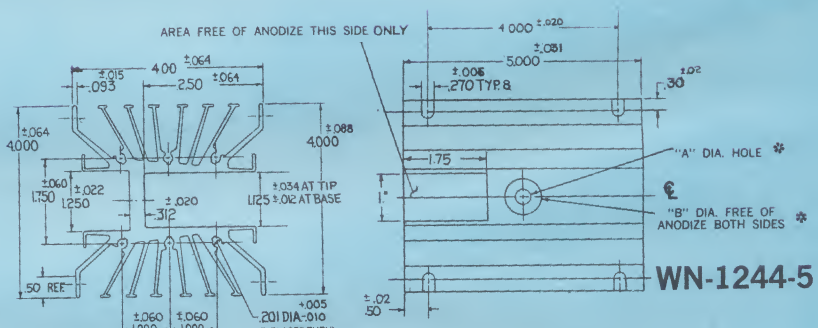


NATURAL CONVECTION CHARACTERISTICS

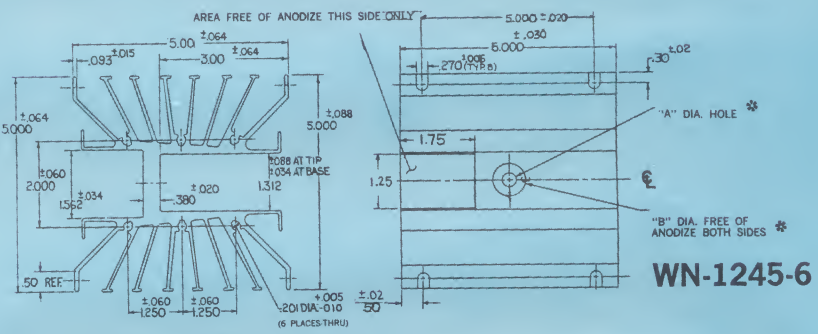
. . . taken under rigidly controlled lab conditions.



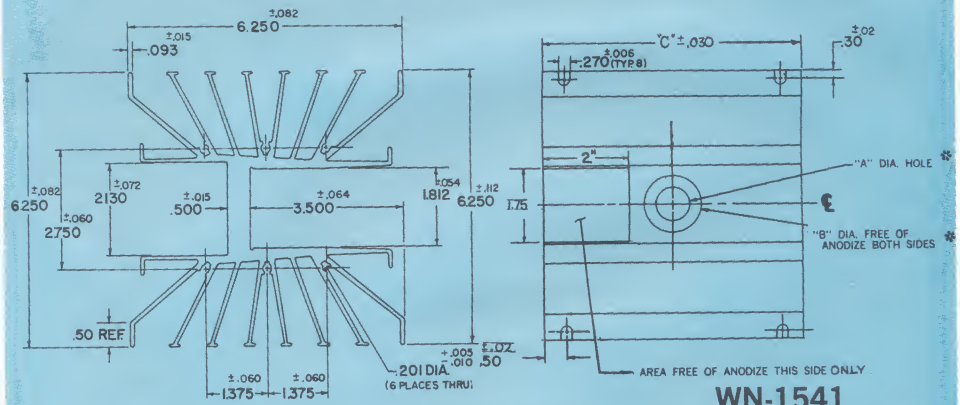




WN-1244-5



WN-1245-6



WN-1541

Model No.	Dim. "C"
WN-1541-6	6.00
WN-1541-9	9.00

MATERIAL: Aluminum alloy 6063T5 per QQ-A-200.
FINISH: Black anodize per MIL-A-8625 Type II.

*NOTE: For Ordering Instructions and Mounting Accommodations, see page 14. For Fasteners and Insulators, see page 13. For Thermal Joint Compound, see page 16. For Weights, see page 15. For Extrusions, page 3.

DELTA DIVISION

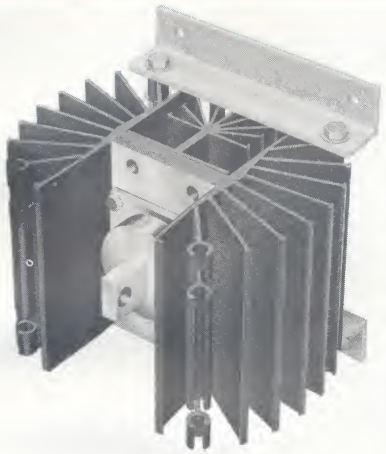
SERIES MN

SERIES MN KING SIZE HEAT SINKS (and INSERTS) . . . for high power rectifiers as large as 3½" x 3½" square plate

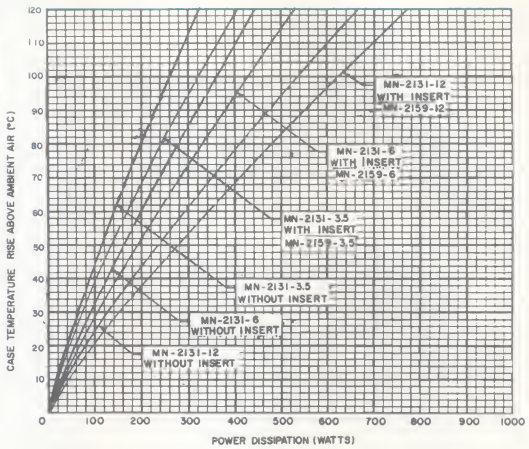
Series MN-2131 Natural Convection Heat Sinks are designed to mount and cool multicell high power rectifiers as large as 3½" x 3½" 650 ampere square plate types. Each of three models are available with Series MN-2159 Heat Sink Inserts for increased heat dissipation. The Model MN-2131-12 Cooler, with its associated Model MN-2159-12 Insert, under natural convection conditions will permit a case temperature rise of a 3½" x 3½" rectifier of only 110°C at 600w dissipation.

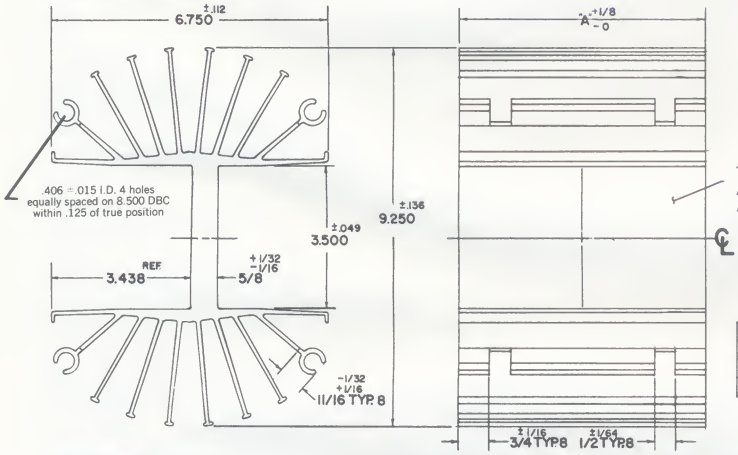
The aluminum King Size Heat Sink and Insert are black anodized except at the semiconductor mounting surface for the electrical stud connection and high current busswork. MATERIAL: Aluminum alloy 6063-T5 per QQ-A-200. FINISH: Black anodize per MIL-A-8625 Type II.

Physical mounting can be accomplished two ways: (1) By using the four integral mounting lugs provided in each end and standard ⅜" dia. bolts, nuts and washers. A nut fits into the slot provided with full wrench access, then the bolt and washer are inserted. (2) Type 109 Mounting Brackets (glass fiber reinforced plastic angles) are available for wall mounting and insulating Series MN Heat Sinks.



NATURAL CONVECTION CHARACTERISTICS

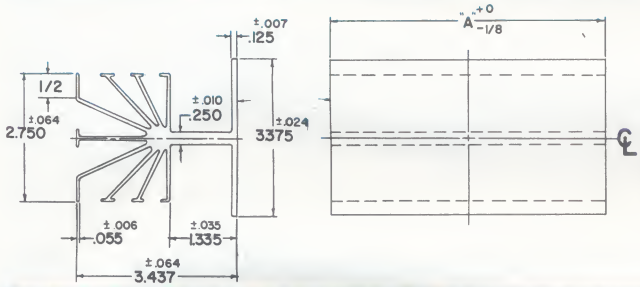




THIS SURFACE FREE OF ANODIZE FOR BUSING AND SEMICONDUCTOR MOUNTING

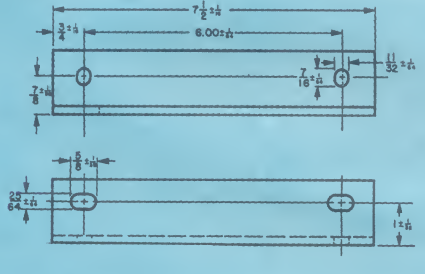
MODEL NO.	DIM. A
MN-2131-3.5	3.5
MN-2131-6.0	6.0
MN-2131-12.0	12.00

Series MN-2159 Inserts are available for use with Series MN-2131 Heat Sinks.



MODEL NO.	DIM. A
MN-2159-3.5	3.5
MN-2159-6.0	6.0
MN-2159-12.0	12.00

Type 109 Mounting Brackets (glass fiber reinforced plastic angles) provide convenient, economical mounting as well as 5000v stand off insulation strength. Standard ⅜" machine bolts 1½" long may be used to affix brackets to Series MN Heat Sinks, but are not supplied.

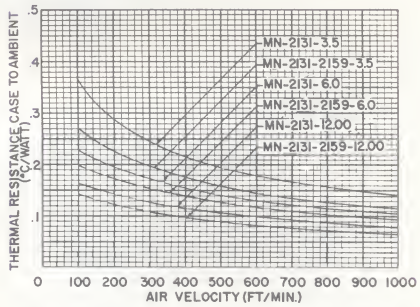


MATERIAL: Glass Fiber Reinforced Plastic per MIL-C-8013.

FORCED CONVECTION CHARACTERISTICS

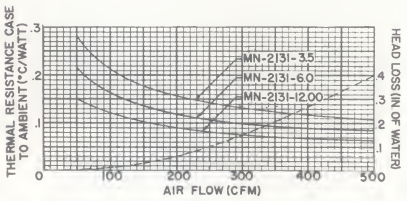
For thermal impedance lower than natural convection thermal impedance, forced air may be used. Chart No. 1 is for sinks in a large duct carrying a stream of .075 lbs/ft³ air with velocity as shown on curves. Each of the three models is shown with and without a Series MN-2159 Insert.

1.

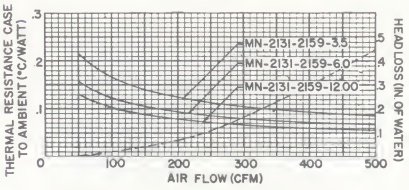


Charts No. 2 and 3 are for sinks in closely confined ducts. The cfm of .075 lbs/ft³ density air flowing through each sink is shown on the curves along with the static head loss across the sink. Chart No. 2 is for units without Inserts and Chart No. 3 is with Inserts in the Heat Sinks.

2.



3



NOTE: For Ordering Instructions and Mounting Accommodations, see page 14. For Fasteners and Insulators, see page 13. For Thermal Joint Compound, see page 16. For Weights, see page 15. For Extrusions, page 3.

C° -60 -40 -20 0 20 40 60 80 100 120 140 160 180 200 220 230

F° -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440

NEW . . . "BLIND" INSULATING FASTENERS, STANDARD TEFLON MOUNTING INSULATORS AND WASHERS

DELTA DIVISION **SERIES 100**

NEW "BLIND" MOUNTING DEVICES

New WAKEFIELD Fasteners and Insulators are available to permit rapid mounting of heat sinks to panels and circuit boards. Effective electrical isolation of the heat sink from its mounting is obtained. This eliminates the necessity for mica or other insulating wafers with their attendant thermal resistance, thereby effecting a reduction in semiconductor junction temperature.

Type 100 Fastener is for rapid, reliable blind fastening of the new Series 140 Heat Sinks to pc boards or panels. A fastener is inserted thru the heat sink and panel holes. Then the head is tapped to expand the back or blind side to accomplish the fastening.

† Type 102A Fastener with Type 102N(Nylon) or 102F(Fiber) Insulating Washer forms an insulating fastener used for electrical isolation and mounting. See Figure 13A.

Types 104 and 106 Insulators with #8 screws also are "blind fasteners" but with built-in insulating ability. A #8 sheet metal or machine screw expands the fastener on the blind side when driven in. The ¼" Nylon head spaces and insulates the heat sink from the panel, such as seen in Figure 13B.

Since Types 100, 102, 104 and 106 are pre-moistened, they should be kept sealed in the plastic bags or other air-tight containers prior to installation. If any of these types crack or break during installation, the others should be dipped in hot or boiling water for five minutes before using. Only at the time of application is moisture content important. Do not store these in areas where relative humidity is low or in direct warm air drafts. These Nylon Insulators may be operated continuously at 100°C maximum. Do not install in temperatures below 32°F.

	Type 100	† Type 102A	Type 104	Type 106
"BLIND" NYLON INSULATING FASTENERS		* Type 102F (Fiber) or 102N (Nylon) Washer		
Panel hole dia.	.125±.005	.187±.005		
Panel thickness	.093 max.	.125 max. .063 max. with 102F or 102N		
Accepts screw (not furnished)			#8 sheet metal or machine	#8 sheet metal or machine
Screw length			Panel + 5/8"	Panel + 3/4"
Shoulder dia.	¼	⅜	⅜	½
Hypot volts		1.5kv with washer	3kv	3kv

* Washer O.D. = 7/16", I.D. = 13/64"±.005 and thickness = 1/16"±.006.

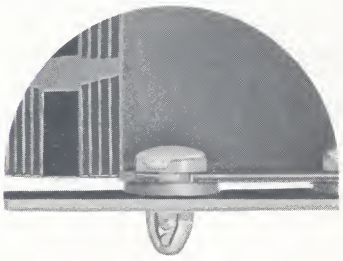


Figure 13A

† For Matched quantities of Type 102A Fasteners with Fiber (F) or Nylon (N) Washers, order Type 102A-F or 102A-N Insulating Fasteners respectively.

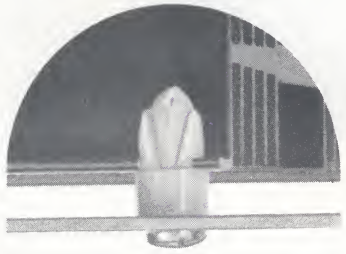
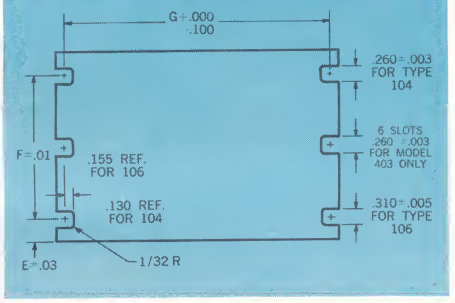


Figure 13B

Type 104 Insulator and #8 screw fasten a Type NC-403 Heat Sink to a panel.

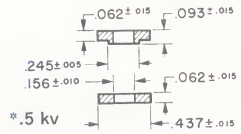
Mounting Slot Dimension for * — 4 versions of standard heat sinks used with Types 104 and 106 nylon insulators.



STANDARD TEFLON MOUNTING INSULATORS AND WASHERS

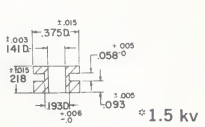
WAKEFIELD Type 101 Washer and Types 103, 105 and 107 Mounting Insulators also are available to permit effective electrical isolation of the heat sink from the panel or pc board. Type 107 is a high voltage version of Type 103.

Type No. 101 Washer Pr.



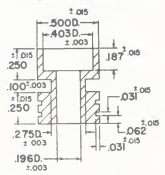
*.5 kv

Type No. 103 Insulator



*1.5 kv

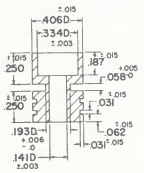
Type No. 105 Insulator



*5.0 kv

*Hypot

Type No. 107 Insulator



*5.0 kv

WAKEFIELD HEAT SINK INSULATOR REQUIREMENTS

Heat Sink Model No.	**Page No.	Type of Insulator 100	101	102 A	103	104	105	106	107	109	No. Req	Mounting Slot Dimensions for Types 104 and 106 E	F	G
NC-140/141/142	2	X									2			
*NC-301	5			X	X	X			X		2	.37		1.62
*NC-302	5			X	X	X			X		4	.37	.75	1.62
*NC-303	5			X	X	X			X		4	.50	2.00	1.62
*NC-401	6			X	X	X			X		**3	.37	.75	4.375
*NC-403/413/421	6			X	X	X			X		4	.50	2.00	4.375
*NC-423	6			X	X	X			X		4	.50	4.50	4.375
*NC-441	6						X	X			4	See page 6		
NC-501	7		X								3			
NC-502/503/504/505	7		X								4			
*NC-621	8			X	X	X			X		4	.37	.75	4.375
*NC-623	8			X	X	X			X		4	.50	2.00	4.375
*NC-641	9			X	X	X			X		4	.50	2.00	3.750
*WN-1244/1245/1541	11						X	X			4	See page 11		
MN-2131	12									X	See page 12			

* When ordering Heat Sink to be used with Type 104 or Type 106 Mounting Insulator, add the suffix -4 to the Heat Sink Model No. For example, NC-302-4-NN will bring the right mounting slots on the NC-302-NN for the Type 104 Insulator. See page 14 for complete example on Ordering Instructions.

** For dimensions other than mounting slot size and location, see page listed here next to the Heat Sink Model No.

DELTA WAKEFIELD DIVISION

HEAT SINK ORDERING INSTRUCTIONS AND MOUNTING ACCOMMODATIONS

ORDERING INSTRUCTIONS

1. Quantity.
2. Heat Sink Model No.
3. Suffix letter for the semiconductor mounting accommodation desired. (Refer to table below to determine the mounting accommodations available on each cooler. Numbers under the suffix letters refer to Figures 1 to 28.) "K" is blank . . . no holes. If more than one mounting accommodation is desired on a Heat Sink, simply add additional mounting suffix letters. For instance, "NC-403-AA" is the designation for the NC-403 Heat Sink with two "A" mounting groups per Figure 2 below.
4. Specify Mounting Insulators if desired by adding insulator type number as final suffix. Example: NC-403-AA-103, for Type 103.
5. If Type 104 or 106 Insulators are desired, then add -4 suffix to Heat Sink Model No. See * on page 13. Example: NC-403-4-AA-104, with last suffix denoting insulator type.
6. For Series 500, specify Top Cover and/or Hose Adapter if desired.

EXAMPLE: 10 pieces — NC-302-4-NN-104. (Specifies ten model NC-302 Coolers with two ¼ - 28 semiconductor mounting accommodations, one on each end, with 4 each Type 104 Mounting Insulators.) See insulator tabulation on page 13.

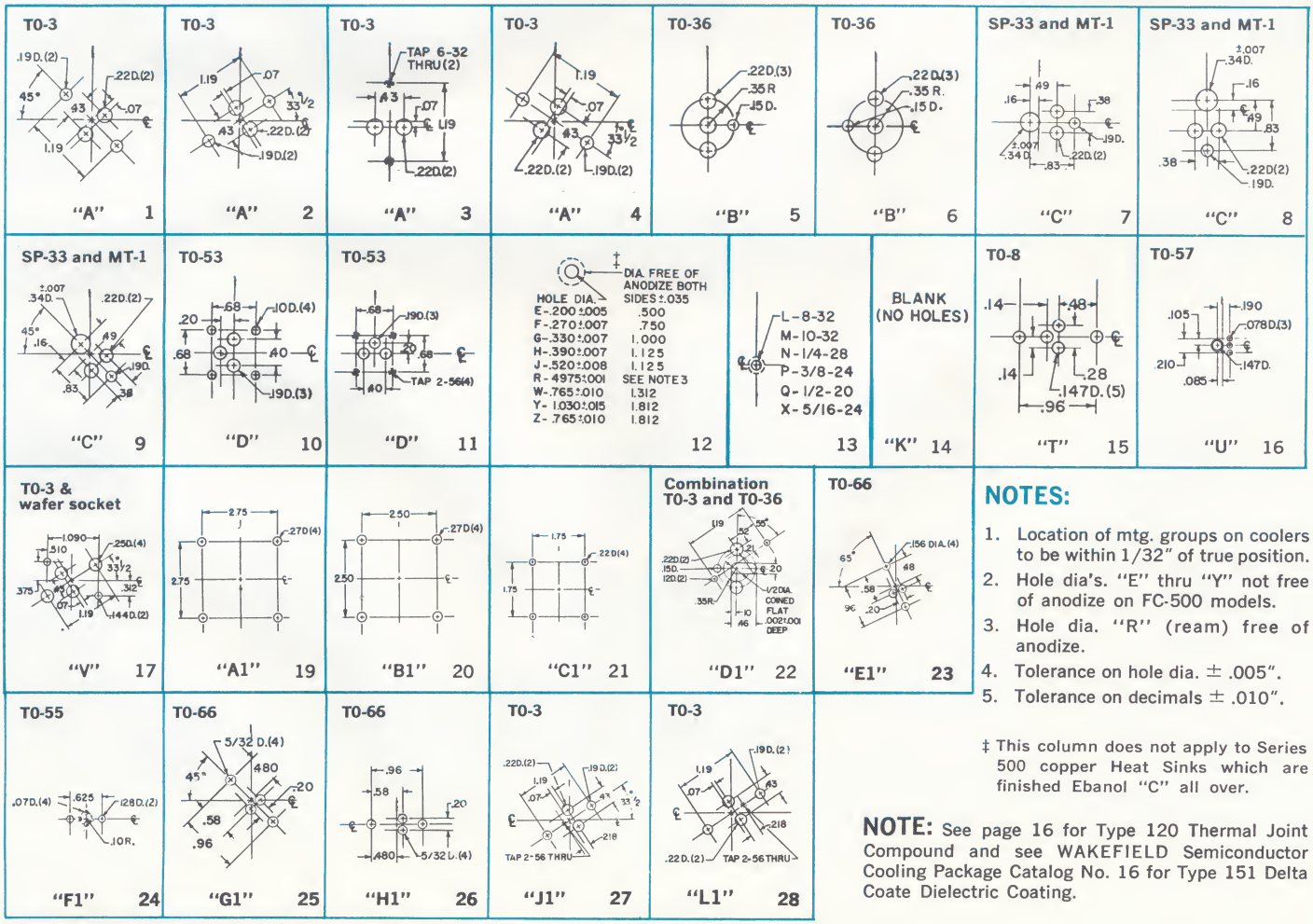
MOUNTING ACCOMMODATIONS FOR SEMICONDUCTORS ON HEAT SINKS

Cooler Model No.	SUFFIX LETTER FOR ORDERING. Figure under letter designates Figure No. under Mounting Specifications.																												
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	A1	B1	C1	D1	E1	F1	G1	H1	J1	L1
*301											*13	*13	*13			12																	
302/303											13	13	13			12																	
401/403/413 421/423	2	5	7	10	12	12	12	12	12							12	15	16	17	12							22	23	24		27	28
441								12	12											12								23	24		27	28
‡501/502/503	3	5	8	11	12	12	12	12	12											12								23	24			
504/505											13	13	13	13	13						13							23	24			
601/603					12	12										12	15	16											24		26		
621/623/641	4	6	7	10	12	12	12	12	12							12	15	16	17	12							22	23			26		
680	1	5	9	10	12	12	12	12	12							12		16												25			
GN-1157-5							12	12	12																							
WN-1244-5							12	12	12																							
GN-1251-5.5								12	12																							
WN-1245-6								12	12											12												
WN-1541-6 WN-1541-9																				12		12	12									
MN-2131																				12		12	12	19	20	21						

14 — BLANK — NO HOLES

*Suffix letters so marked can be supplied on one end only of Model NC-301.

MOUNTING SPECIFICATIONS



NOTES:

1. Location of mtg. groups on coolers to be within 1/32" of true position.
2. Hole dia's. "E" thru "Y" not free of anodize on FC-500 models.
3. Hole dia. "R" (ream) free of anodize.
4. Tolerance on hole dia. ± .005".
5. Tolerance on decimals ± .010".

‡ This column does not apply to Series 500 copper Heat Sinks which are finished Ebanol "C" all over.

NOTE: See page 16 for Type 120 Thermal Joint Compound and see WAKEFIELD Semiconductor Cooling Package Catalog No. 16 for Type 151 Delta Coate Dielectric Coating.

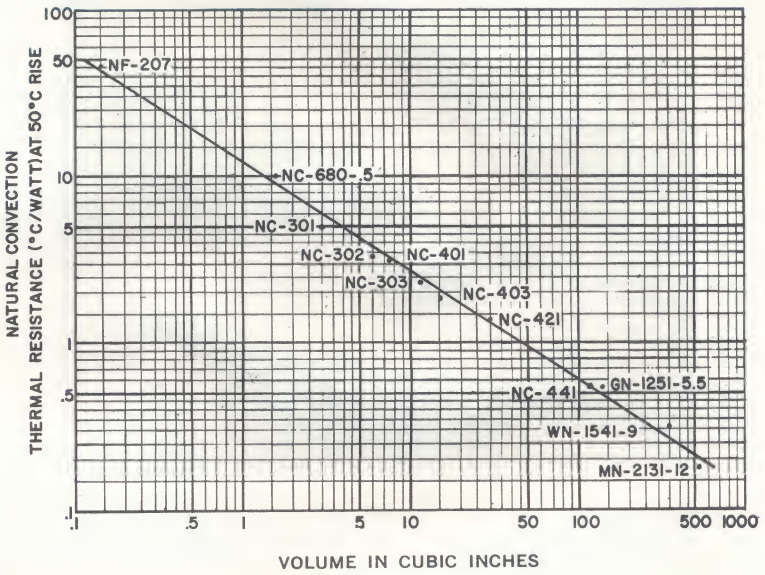
HEAT SINK PERFORMANCE vs. SPACE REQUIRED . . .

WAKEFIELD DELTA DIVISION

Data to right . . . Heat Sink Performance vs. Space Required illustrates the fact that natural convection heat dissipation by means of a finned dissipator is a function of the volume contained within the envelope of the dissipator. The curve, a straight line plot on log paper, shows natural convection thermal resistance (°C/watt), at a 50°C rise of the heat sink mounting surface above ambient, versus the volume occupied by the heat sink in cubic inches.

For example, a Wakefield Engineering NC 441 natural convection heat sink has cross section envelope dimensions of 4.5 x 4.75 inches with a length of 5.5 inches. This means that the total volume occupied by the 441 is 118 cubic inches. The curve shows that a heat sink with 118 cubic inch volume will have impedance of .55 degrees C/watt. The actual test data for the NC 441 as obtained in the laboratory indicates a thermal impedance of .55 degrees C/watt at a mounting surface temperature rise of 50 degrees C. In calculating the volume of sinks with extruded mounting feet such as 403 and 421, disregard the mounting feet when determining envelope dimensions. For example the 403 should be considered to have envelope dimensions of 1.25 x 4 x 3 and volume of 15 cubic inches.

If there is a specific volume of space available for fitting in a heat sink, the thermal resistance of an "optimum" heat sink can be accurately approximated from the curve. By "optimum", it is meant that the ratio of cross-section to length, fin spacing and thickness, finish, and mounting orientation, all meet the high design standards as illustrated in Wakefield Engineering designs.



WEIGHTS OF STANDARD HEAT SINKS AND ACCESSORIES

WEIGHTS

Model No.	Approx. Wt.
NC-140	.14 oz.
NC-141	.20 oz.
NC-142	.42 oz.
NC-150	.10 oz.
NF-201	.05 oz.
NF-202	.025 oz.
NF-203	.08 oz.
NF-204	.03 oz.
NF-205	.05 oz.
NF-207	.08 oz.
NF-209	.12 oz.
NF-211	.05 oz.
NF-213	.08 oz.
NF-215	.12 oz.
NF-222	.10 oz.
NF-224	.12 oz.
TR-254-P	.20 oz.

Model No.	Approx. Wt.
TR-254-S	.25 oz.
TR-254-SI	.25 oz.
TR-254-T	.45 oz.
TR-255	.10 oz.
NC-301	1 oz.
NC-302	2 oz.
NC-303	4 oz.
NC-401	2.5 oz.
NC-403	5 oz.
NC-413	8.5 oz.
NC-421	9 oz.
NC-423	1 lb.
NC-441	1.8 lb.
FC-501	9 oz.
FC-502	1 lb.
FC-503	1.8 lb.
FC-504	7 oz.
FC-505	12 oz.

Model No.	Approx. Wt.
NC-601	.6 oz.
NC-603	1 oz.
NC-621	1.6 oz.
NC-623	3.2 oz.
NC-641	4.4 oz.
NC-680-.5	1.3 oz.
NC-680-.75	1.5 oz.
NC-680-1.0	1.7 oz.
NC-680-1.25	1.9 oz.
GN-1157-5	1.8 lb.
GN-1251-5.5	2.6 lb.
WN-1244-5	1.9 lb.
WN-1245-6	2.8 lb.
WN-1541-6	3.8 lb.
WN-1541-9	5.8 lb.
MN-2131-3.5	3.1 lb.
MN-2131-6	5.5 lb.
MN-2131-12	11 lb.

Model No.	Approx. Wt.
ACCESSORIES	
Inserts	
MN-2159-3.5	11 oz.
MN-2159-6	1.2 lb.
MN-2159-12	2.4 lb.
Insulators	
MOD. 100	.01 oz.
MOD. 101	4 pr. ⅛ oz.
MOD. 102-A	.02 oz.
MOD. 102-F	.01 oz.
MOD. 102-N	.01 oz.
MOD. 103	4 ea. ⅛ oz.
MOD. 104	.03 oz.
MOD. 105	4 ea. ½ oz.
MOD. 106	.04 oz.
MOD. 107	4 ea. ¼ oz.
MOD. 109	3½ oz.

Model No.	Approx. Wt.
Mtg. Adaptors	
MOD. 111 2 REQ'D @ 1 oz. ea.	
MOD. 113 2 REQ'D @ 1½ oz. ea.	
Hose Adaptors	
FCA-501, 502, 504 & 505	1¼ oz.
FCA-503	2¼ oz.
Top Covers	
FCA-501 & 504	½ oz.
FCA-502	1½ oz.
FCA-503	2½ oz.
FCA-505	1 oz.

DELTA BOND 152 THERMALLY CONDUCTIVE ADHESIVE

TYPE 152

An adhesive with high thermal conductivity to be used:

- As a general adhesive
- For bonding semiconductors to chassis heat sinks
- Fabricating heat sinks or thermal links
- For permanent bonding of all materials with highly thermal conductive interface

Delta Bond 152 was introduced to fill the need for a general purpose adhesive which will satisfy many electronic industry requirements. Delta Bond 152 produces a rigid high strength bond to most materials when cured. Being 100% solid adhesive, it is effective on porous and non-porous surfaces such as metals, glass, ceramics, and most plastics.

The main features of Delta Bond 152 are high thermal conductivity, excellent dielectric strength, and a coefficient of thermal expansion which is similar to that of aluminum and copper.

The thermal resistance of a film of Delta Bond 152 may be calculated from the formula: $\theta = \frac{pt}{A}$

where θ = thermal resistance of film in °C/watt

p = specific thermal resistivity of Delta Bond 152 = 47°C in/watt

t = average film thickness in inches

A = film area in square inches

For other values of p, see page 16, Table 2.

TYPICAL PROPERTIES

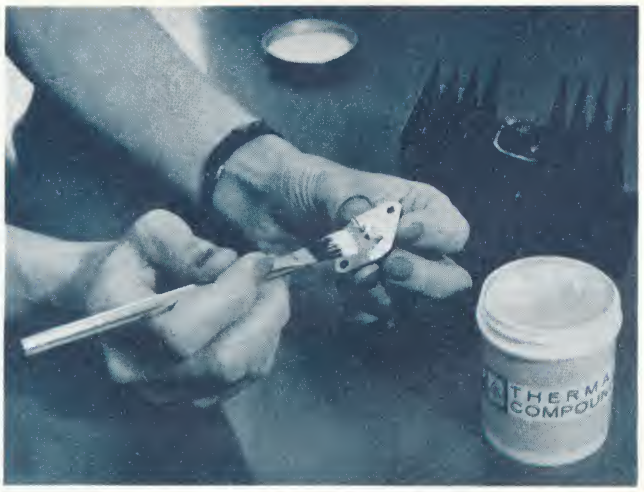
Bond shear strength, 1 inch overlap, psi Room temp. . . . 2,100; −70°F. . . . 1,800; +200°F. . . . 1,400	
Bond shear strength, 30 days immersion in water	Unaffected
Flexural strength, psi	15,000
Thermal resistance, °C inches/watt	47
Coefficient of thermal expansion, per °F.	15 x 10^{-6}
Volume resistivity, ohm-cm. Room temp. . . . 10^{16}; +200°F. . . . 10^{13}	
Dielectric strength, volts/mil (.005" sample)	750
Water absorption (7 days)	Less than 0.1%
Temperature range	−70°F. to +300°F.
Thermal conductivity	.002 gm. cal./sec. cm. ^{2} °C/cm. .484 BTU/hr. ft. ^{2} °F./ft.

	Stock No.	2-Part Kit Size
ORDERING INSTRUCTIONS:	152-1	30 gm. 1 oz.)
	152-2	214 gm. (7.5 oz.)
	152-5	5 lbs.
	152-15	15 lbs.

DELTA DIVISION

TYPE 120

WAKEFIELD THERMAL JOINT COMPOUND



With the introduction and extended use of high power rectifiers, the increase in cooling requirements have become more sophisticated. In order to insure rectifier longevity with power applications in the order of several hundred watts, each element of thermal impedance must be considered carefully.

Type 120 Thermal Joint Compound was developed to reduce the high thermal impedance of an air gap present between the mating surfaces of the semiconductor case and the heat sink surface. Type 120 Compound fills the minute air gap between the mating surfaces with a grease-like material which possesses an excellent thermal resistance of only 0.05°C/w for a 0.001" film with an area of one square inch.

Type 120 Thermal Joint Compound Specifications (Typical Values)

Volume Resistivity	5 x 10^{14} ohm centimeters
Dielectric Strength	225 volts/mil
Specific Gravity	2.45
Thermal Conductivity @ 36°C.	.00177 gm cal/sec, cm^2/°C/cm
	.4295 BTU/hr, ft^2 °F/ft
Bleed, % after 24 hrs. @ 200°C.	0.0
Evaporation, % after 24 hrs. @ 200°C.	0.5
Color	opaque white

Type 120 Compound will not harden, dry out, or melt after 1,000 hours at 200 degrees C.

For maximum performance, proper mounting torque should be used on all stud-mounted devices and Thermal Joint Compound applied to increase heat flow.

NOTE: Request Bulletin No. 120-B for "The Effects of Torque and No. 120 Thermal Joint Compound on Thermal Impedance".

ORDERING INSTRUCTIONS:	Stock No.	Container Size
	122	2 oz.
	128	8 oz.
	1280	5 lbs.

THERMAL RESISTANCE

Table 1 below shows maximum thermal resistance, case-to-sink, for various popular semiconductor case styles as a function of the sum of sink and semiconductor surface flatness expressed in inches per inch total indicator runout. For example, if the semiconductor case has .001 inches/inch TIR and the sink mounting surface has .002 inches/inch TIR, the reference value in the table will be .001 + .002 = .003 inches/inch. It should be noted that the table values are the worst case, and that average values of thermal resistance will be lower. Temperature measurements for Table 1 are made per section 2, "Semiconductor Cooling — Theory & Practice", a booklet available upon request from Wakefield Engineering, Inc.

TABLE 1

Case Type	Mounting Surface Thickness in inches (6063 aluminum)	Mounting Torque (in.-lbs.)	Maximum thermal resistance case-to-sink in °C/watt for various semiconductor case styles when using Type 120 Joint Compound. Heat sink surface flatness + semiconductor surface flatness (both quantities expressed in inches/inch total indicator runout).					
			.001	.002	.003	.004	.005	.006
TO3	.18	—	.045	.09	.13	.17	.21	.24
TO36	.18	15	.03	.07	.10	.13	.17	.20
TO8	.18	—	.05	.11	.16	.21	.27	.32
MT-1 (2N1016)	.18	50	.04	.08	.13	.17	.21	.25
3/16 stud x 3/16 hex	.18	15	.08	.16	.24	.32	.40	.48
1/4 stud x 11/16 hex	.18	30	.05	.10	.14	.19	.24	.29
3/8 stud x 11/16 hex	.37	75	.035	.07	.11	.14	.18	.22
1/2 stud x 11/16 hex	.37	125	.035	.07	.11	.14	.18	.22
3/4 stud x 1 1/4 hex	.50	600	.026	.052	.078	.104	.130	.156

For other applications such as the mounting of power resistors, the thermal resistance of a film of 120 compound may be calculated from the formula:

$$\theta = \frac{pt}{A}$$

where θ = thermal resistance of film in °C/watt

p = specific thermal resistivity of 120 Joint Compound = 56°C inches/watt

t = average film thickness in inches

A = film area in square inches

Value of p for various materials of interest are listed in Table 2

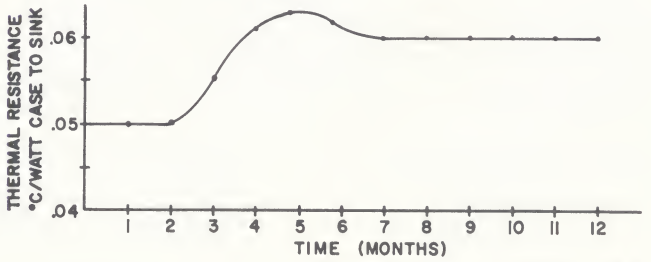
TABLE 2 VALUES FOR p (°C IN/WATT)

Still air	1200
Silicone grease	204
Mylar film	236
Mica	66
Type 151 Delta Coate	61
Type 120 Joint Compound	56
Type 152 Delta Bond	47
Aluminum	0.19
Copper	0.10

TIME vs. THERMAL RESISTIVITY

A 12-month test on TYPE 120 Thermal Joint Compound was made to determine the effects of time and temperature on thermal resistivity across the mating surfaces of a semiconductor and a heat sink. The test data clearly showed that there is a 20% increase in thermal resistance after approximately 6 months. Then stabilization occurs. There is no measurable increase for the remainder of the 12-month test period.

Monthly measurements were made on three test units. Worst case data is plotted below. Conclusion: No measurable increase in case temperature of a mounted semiconductor on a heat sink after the six month period of stabilization.



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